Food habits and selective grazing of Mongolian gazelle (*Procapra gutturosa*) in Hulunber Grassland

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Abstract The food availability, composition of the diets and selective grazing of the Mongolian gazelle (*Procapra gutturosa*) were studied in Hulunber Grassland in Nei Monggol. The food availability of Mongolian gazelle showed seasonal changes. The plant biomass was higher in spring and summer than that in autumn and winter. The fecal compositions of the gazelle demonstrated that fibrous parts occupied 62.4%, 74.8%, and 66.0% in spring, autumn, and winter, respectively. The Mongolian gazelle preferred to graze *Compositeae*, *Leguminosae, Allium* spp. and other forbs in spring and autumn, while the grasses, such as *Aneurolepidium chinense* and *Stipa* spp. were selectively feeding in winter.

Key words: *Procapra gutturosa*, Food availability, Food habits, Selective grazing

Introduction

Mongolian gazelle (*Procapra gutturosa*) is a special ruminant species that has numerous populations in the eastern part of Nei Monggol Grassland and a significant component of the grassland ecosystem. This species has the habit to select species and quality of plants to graze. However, the population has decreased dramatically and faces extinction in China (Jiang *et al.* 1998). Therefore, it is very important to study the food habits and food choice by Mongolian gazelle for promoting the protection and management of remaining population.

In a previous paper (Gao *et al.* 1995), it was reported that the food habits of the Mongolian gazelle grazed predominantly grass species in the Hulunber Grassland in winter. However, the botanical composition of the fecal contents of the gazelle was only analyzed. Food availability and food choice are closely related to the feeding strategy of the ruminants. The availability and distribution of forage plants together influence the feeding behavior, feeding type, and even social organization of the ruminants (Geist 1974; Jarman 1974). The main object of the present study is to find out the food availability and how to be selectively grazed by Mongolian gazelle in different seasons.

Study areas

Our study sites were in Xinbarhu Right Banner (47°39″ ~ 49°50″ N, 115° 00″ ~ 117° 48″ E), which was situated in the southwestern part of the Hulunber League, in the eastern Nei Monggol. The average elevation is about 600 m and above. Bainwula Mt. exhibits the highest elevation (1 038 m), while Hulun Lake (covering 2 200 km^2) is the lowest place (540 m). Around Hulun Lake, Beier Lake, and Wuersun River, rich water systems such as Erguna River and Hulun Lake have developed in the lowlands. The area belongs to the cold temperate continental semiarid climatic zone. The average annual temperature is from –3℃ to 0℃. The lowest temperature is below -40 ℃ and the highest around 35~40℃. The frost-free period is 80~120 d and the annual precipitation varies around 250~380 mm, of which 70% falls in summer. The main natural calamities for the Mongolian gazelle are frostbite, snow, and snowstorm.

The vegetation belongs to the cool temperate tall grassland. The grassland is categorized into five types according to the species composition: The *Stipa grandis--Aneuropidium chinense* type, the *Stipa grandis--Cleistogenes squarrosa* type, the *Cleistogenes squarrosa--Lespedeza* spp. type, the *Artemisia frigida* type, and the *Aneuropidium chinense--Stipa grandis*--Herbs type (Hu *et al.* 1992). The vegetative period begins from early May and ends in the end of September.

Materials and methods

Food availability

The food availability of the Mongolian gazelle was studied in June, August, and October of 1997 and early April of 1998. Grassland was classified into

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three types according to grazing intensities: heavily grazed, moderately grazed and lightly grazed. In all types of grasslands, the coverage (%) was estimated by 1 m×1 m plots randomly. All the above ground parts of plants were cut by a clipper and then identified and grouped. Dominant species were separated from minor species including other grasses, sedges and other forbs before all plants were put into paper bags. Plant samples were dried at 80 ℃ over 48 h in an electric oven until the weight becomes invariable. With an electric balance all samples were weighed by the accuracy of 0.1 g at the Laboratory of the Wildlife Ecology and Management in Northeast Forestry University. The mean dry weight of the samples was accounted for each type.

Dietary composition

Dietary composition of the Mongolian gazelle was examined by the fecal analysis method (Gao *et al.* 1995). Four or five pellets were sampled from each rectum of 60 Mongolian gazelles in May, November of 1997 and February of 1998. They were put into aperture sieve (2 mm) and washed away the mucus surrounding the pellets with water, then preserved in 60% ethanol. Plant fragments were microscopically observed and identified by comparing the samples to be made epidermal standards of major plants.

The point frame method was used for quantitative evaluation (Stewart 1967). Plant fragments were spread over a slide with a grid of 1 mm × 1 mm, and grid points covered by plant fragments were recorded for each plant category. A hundred points are usually counted (Chamrad & Box 1964), but several researchers count 200 (Casebeer & Koss 1970; Buchanan *et al.* 1972). To ensure accuracy, 300 points were counted in this study.

Selective feeding

Ivlev's (1961) election index (E) was applied to estimate the forage selectivity by Mongolian gazelle in this study. This index is defined as follows:

$$E=(R_i - P_i)/(R_i + P_i) \qquad (-1 \leqslant E \leqslant 1)$$

Where R_i is the proportion of species i in the diet, and P_i is the proportion of species i in the availability food. Plus values of election index (E) indicate positive selection; while minus values indicate low preference or avoidance. An election index (E) of 0 represents selection in proportion to availability.

Results

Food availability

Seasonal changes in plant availability in the habitat of Mongolian gazelle are shown in Table 1. The total biomass in moderately grazed places is much significantly heavier than that in lightly grazed places. In spring and in summer, the total biomass of lightly grazed places reaches 121.3 g•m^{-2} and 139.0 g•m^{-2} respectively. In moderately grazed places, however, the total biomass is only 59.9 g•m^{-2} and 77.0 g•m^{-2} in corresponding seasons. The total biomass is even smaller in heavily grazed places because of cattle over-grazing. The biomass of autumn and winter is also different significantly between the moderately grazed and lightly grazed plots. These indicate that food availability of Mongolian gazelle is greatly influenced by cattle grazing intensity.

Table 1 shows that *Aneurolepidium chinense* is the most abundant grass, followed by Stipa spp., other grass and forbs. *A. chinense* and *S.* spp. together accounted for 40.0%~89.1% of the total biomass among different seasons. The biomass of graminoids is greater than that of forbs. In moderately grazing places, however, the value of ratio is relatively smaller than that in lightly grazing places. During snow season, the food availability decreased greatly. The total biomass above the snow (about 20.0 cm in the depth) is only 0.6 g•m^{-2}, and main plants are *S.* spp. and *A. chinense* that occupy 57% of total biomass.

Dietary composition

Aneurolepidium chinense, Stipa, Carex and *Allium* spp. can be identified to species or genus level according to their epidermal characteristics, so do some *Compositae* species like *Artemisia* spp., *Leguminosae* spp. and *Allium* spp. *(Liliaceae)*. It's hard to identify other forbs. Culms, sheaths, and stems were categorized to rough food blocks because they are very hard to be identified to species level. The remaining fibers after culms and stems are digested are impossible to be distinguished; thus all of them were categorized as "fibrous materials". Category "others" includes flowers, fruits, seeds and unidentifiable materials.

Fecal compositions of the Mongolian gazelles are shown in Table 2. The proportions of fibrous parts are 62.4%, 74.8%, and 66.0% respectively in spring, autumn, and winter. *Aneurolepidium chinense* and *Stipa* spp. are accounted for 4.3% and 6.8%, respectively in spring. Forb leaves occupy 8.4%, 6.4%, and 6.2% in spring, autumn, and winter, respectively. No flower parts were found even in spring. In autumn, *Stipa* spp. slightly increases to 7.6%, while *Aneurolepidium chinense* decreases to only 1.0%. *Stipa* spp. furthers increases even higher (11.8%) in winter. Although the proportion of grasses respectively occupy only 12.7%, 8.6%, and 14.1% in spring, autumn, and winter, it increases to 33.7%, 33.9%, and 41.5% correspondingly, if the proportions are calculated after removing the fibrous parts.

Table 1. Seasonal changes of the food availability (dry weight, g•m^{-2}) of moderately and lightly grazed places in Hulunber Grassland, Nei Monggol from 1997 to 1998

Plants grazed	Moderately grazed places				Lightly grazed places				Above snow
	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Winter
Aneurolepidium chinense	15.3(25.5) *	28.9(37.5)	12.3(43.5)	12.1(40.1)	0.1(0.1)	35.1(25.1)	21.4(31.7)	20.8(33.7)	0.16(25.00)
Stipa spp.	12.1(20.2)	12.3(17.9)	3.3(11.7)	3.4(11.3)	100.7(83.0)	54.7(39.1)	5.6(8.3)	5.5(8.9)	0.41(64.10)
Other grasses	18.7(31.2)	26.3(34.1)	10.5(37.1)	10.1(33.7)	19.2(15.9)	19.3(13.8)	23.7(35.1)	20.5(33.2)	0.07(10.90)
Total graminoids	46.0(76.9)	68.9(89.5)	26.1(92.2)	25.6(85.3)	120.0(98.9)	109.0(78.0)	50.7(75.0)	46.8(75.9)	0.64(100.00)
Compositeae	4.2(7.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	2.8(2.0)	0.0(0.0)	0.0(0.0)	0.00(0.00)
Leguminosea	0.0(0.0)	1.4(1.8)	0.2(0.7)	1.0(3.3)	0.0(0.0)	5.0(3.6)	5.1(7.5)	4.9(7.9)	0.00(0.00)
Other forbs	9.7(16.2)	6.7(8.7)	2.0(7.1)	3.4(11.3)	1.3(1.1)	22.9(16.4)	11.8(17.5)	10.0(16.2)	0.00(0.00)
Total forbs	13.8(23.1)	8.1(10.5)	2.2(7.8)	4.4(14.7)	1.3(1.1)	30.7(22.0)	16.9(25.0)	14.9(24.1)	0.00(0.00)
Total	59.9	77.0	28.3	30.0	121.3	139.7	67.6	61.7	0.64

Note: *—The number in the bracket stands for percentage.

Table 2. Seasonal changes of the botanical compositions of the feces of Mongolian gazelles in Hulunber Grassland, Nei Monggol from 1997 to 1998 %

Plants found in feces	May (N=15)		November (N=25)		February (N=20)	
	Mean	SD	Mean	SD	Mean	SD
Aneurolepidium chinense	4.3	2.3	1.0	0.7	2.1	1.8
Stipa spp.	6.8	3.5	7.6	1.8	11.8	2.5
Carex spp.	1.2	0.5	0.0	0.1	0.1	0.1
Other graminoids	0.4	0.5	0.0	0.0	0.0	0.1
Total graminoids	12.7	2.1	8.6	2.3	14.1	0.0
Compositae	6.2	2.7	4.0	1.8	3.2	1.2
Leguminosae	1.5	1.0	0.5	0.6	0.9	0.5
Allium spp.	0.0	0.0	0.2	0.3	0.0	0.1
Other forbs	0.7	1.1	1.7	1.1	2.0	0.6
Total forbs	8.4	2.0	6.4	2.8	6.2	1.3
Total leaves	21.2	6.9	15.0	6.7	20.2	10.8
Fiber	29.9	6.2	40.5	9.2	30.8	16.5
Stem	18.0	3.5	18.7	5.3	20.5	10.3
Culm	14.4	4.3	15.4	7.3	14.7	7.2
Others	11.7	6.6	7.5	5.0	9.7	5.6
Unkown	4.7	3.9	2.9	2.6	4.2	2.2
Total fibrous parts	62.4		74.8		66.0	
Total browses (without fiber)	22.4		25.4		18.1	
Total grasses (without fiber)	33.7		33.9		41.5	

Discussion

The food availability in the habitat of the Mongolian gazelle exhibits a remarkable seasonal change (Table 1). In the Hulunber Grassland, the vegetative period lasts only about five months from May to September. Therefore, the food availability is abundant in spring and summer. In contrast, the autumn and winter are dormant seasons of plants lasting about seven months from the end of September to early May (Pan *et al.* 1992). It is no doubt that this is a long period of very poor food availability. In addition, nutrients, fiber contents in this period are not so suitable for Mongolian gazelle as in spring and summer. Crud protein contents of grasses are even lower than the critical level of protein requirement of ungulates (Sinclair 1975; Van Soest 1982; Fiyxell 1987). In this area, the mean monthly temperature from November to March is below 0 °C, and the lowest value happens in February reaching –24 °C. The daily temperature sometimes goes down at –40 °C. Therefore, Mongolian gazelles suffer a lot from natural calamities such as frostbite and snowstorm (Jiang *et al.* 1998). Sometimes, heavy snow and food shortage caused

the losing of one third or even half of the Mongolian gazelle population (Bannikov 1954). Our study also shows that nutritional shortage caused by poor food availability is the main factor causing numerous deaths of Mongolian gazelle in winter.

The diets of the Mongolian gazelle change as seasons do. Around a whole year, they must manage to survive from a long period of poor food supply.

It is found that grasses occupy the largest portion in feces. This should be an expressive demonstration that grasses are the major part of the Mongolian gazelle diet. Some other studies on the food habits of the Mongolian gazelle also support this. Bannikov (1954) identified 21 plant species in the stomach contents of 22 Mongolian gazelles. Gao *et al.* (1995) approved 38 plant genera in the winter diets of the Mongolian gazelle in Nei Monggol. These studies include *Stipa* spp., *Aneurolepidium chinense, Compositae* and *Allium* spp. etc. *Stipa* spp., *Aneurolepidium chinense* are the major feed in winter.

In spring, Mongolian gazelle ate both grasses and forbs, but dead grasses became dominant in the plant dormant seasons. Remarkable seasonal changes and a very long period of poor food formed its food habits. However, Bell (1971) did a famous study on a grazing community of wild ungulates in East Africa. He found that larger ungulate ate roughage grasses and fibrous parts of plants, while smaller ungulate selectively ate more nutritious foods. Bell considered that body weight of ungulates was key factors in determine their food habits.

Table 3. Forage selectivity of Mongolian gazelles as expressed by Ivlve's election index (*E*)

Plants	Spring	Autumn	Winter
Aneurolepidium chinense	0.53	-0.29	0.58
Stipa spp.	0.46	-0.33	0.35
Carex spp.	0.31	0.17	0.20
Other graminoids	0.11	-0.41	0.22
Compositeae	1.00	0.69	-0.33
Leguminosae	1.00	0.71	-0.59
Allium spp.	1.00	0.96	0.60
Other forbs	0.23	0.31	-0.09

Our date showed that Mongolian gazelle ate grasses mainly and body weight did not affected food habits of that Mongolian gazelle as strongly as Bell principle expected, although it was only a small ungulate. Jarman (1974) emphasized the importance of food abundance and distribution to explain the food habits of African ungulates. Grasses are distributed widely and grow abundantly in the Hulunbeier Grassland, however they are fibrous and less nutritious. Although the election index (*E*) value of forbs is bigger than that of grasses in spring and in summer, Mongolian gazelle whose energy requirements were relatively high could not eat selectively the nutritious foods, such as forbs, because distribution of forbs was smaller in study areas. Contrary to forbs, grasses are mainly grazed by Mongolian gazelle to satisfy the energy needs. So our study agreed with the second view that was suggested by Jarman in 1974.

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